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5 May 1959

MEMORANDUM FOR: Chief, CI Staff

ATTENTION : [redacted] 25X1

SUBJECT : Preliminary Feasibility Study of [redacted] 25X1
[redacted] With a Small Powered Balloon 25X1
and With a Homing Glider

1. Some preliminary calculations and notes on the small powered balloon and on the high altitude homing glider are transmitted herewith as per discussions with [redacted], 25X1
[redacted] of this office on 28 April 1959. 25X1

[redacted] 25X1
Chief
TSS/Engineering Division

DD/P/TSS/ED [redacted] :mt 25X1

[redacted]

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FEASIBILITY OF [redacted] VIA SMALL POWERED BALLOON 25X1

1. General Concept:

An evaluation is made of the characteristics of a small, unmanned, powered balloon required to deliver a very light payload to [redacted] 25X1 in denied areas. Briefly, the operation is visualized as follows:

Upper air wind vectors are plotted as in a free balloon operation. When conditions are favorable [redacted] is notified by radio of the time 25X1 of launch and ETA. P. B. is launched on a pre-set heading. Agent turns on radio or IR beacon. P. B. when in range homes on beacon. When close, the agent controls to close proximity, the payload is discharged, the P. B. then is released to float free of the area, completing the mission.

2. Technical Requirements:

   A. General

      1. Minimum cost

      2. Payload from 2 oz. to 5 #

      3. Wide range of operable weather conditions

      4. Range - 25-100 miles

      5. High reliability

   B. Guidance

      1. Maintain P. B. heading for the flight duration to $\pm 5^{\circ}$

      2. On receipt of signal program a suitable rate of descent

      3. Home on beacon

   C. Radio Control (or IR) Requirements

      1. Give signal to guidance system to allow homing on beacon

      2. Take over rate of ascent and descent from guidance system

      3. Take over directional control from guidance system

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D. Aerodynamic Requirements

1. Speed - sufficient to negate wind velocity at altitude for short duration

2. Sufficient altitude to take advantage of predictable winds

3. Sufficient lift for system weight and payload

3. Aerodynamic requirements are dealt with first to establish physical characteristics. A rough estimate of weight is as follows:

Radio Receiver, Loop Antenna, Batteries	3 lbs.
Guidance, valve	
Ballonet, blowers, ballast	6 lbs.
Propulsion and fuel	6 lbs.
Payload	1 lb.
Balloon weight	2 lbs.
Total Gross Weight	18 lbs.

Balloon volume at 10,000 feet = 375 cubic feet using helium lifting gas

Since volume = $.056L^3$, L = length = 18 feet, maximum diameter = 6 ft.

Surface area = $.81L^2 + .9V^{2/3}$ when V is balloon volume

Fabric wt. = $.03005V^{2/3}$ = 2 lbs.

Assumed wind gradient is as follows:

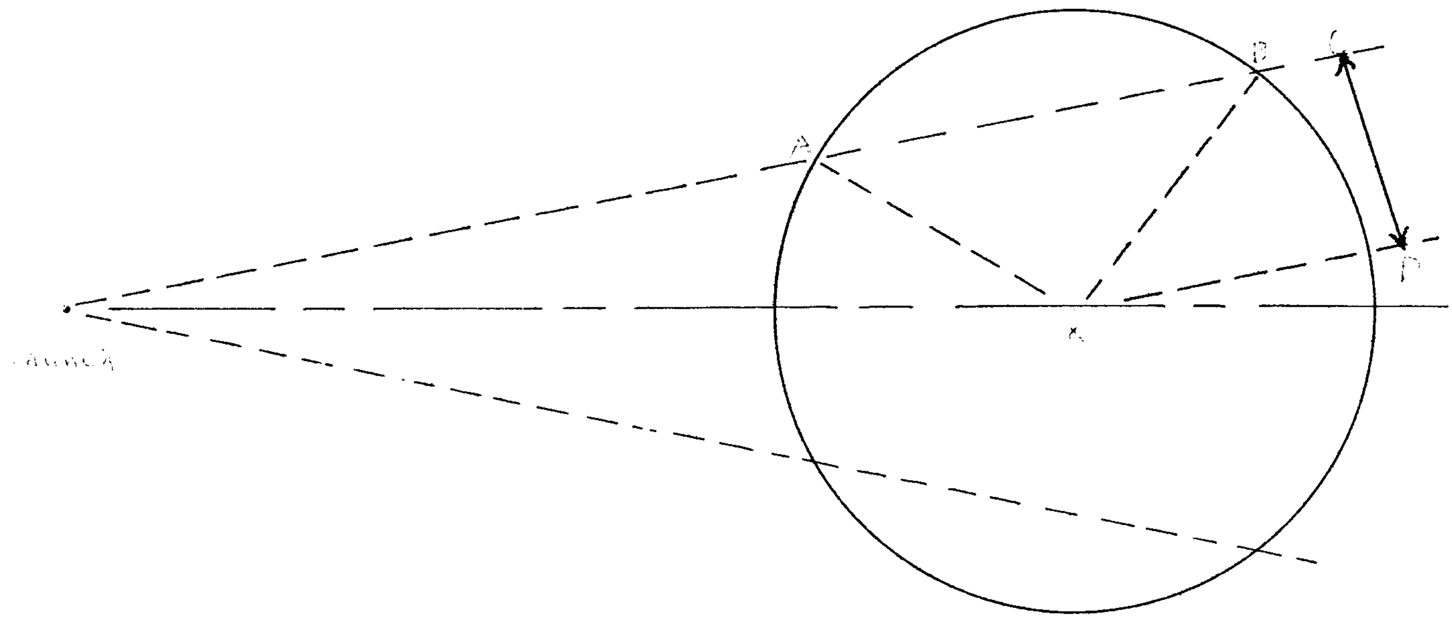
Altitude	Wind Velocity	Ave.
0	0-3	1.5
1	0-5	2.5
2	3-6	4.5
3	4-7	5.5
4	5-8	6.5
5	6-9	7.5
6	7-10	8.5
7	9-15	12
8	13-18	15.5
9	15-20	17.5
10	18-22	20

 [redacted]

[redacted]

Forecasting error ±10% of range and guidance error of ±5° of heading allows P. B. to float to 18.7 miles of the agent. This is rounded off to 20 miles to allow for poor meteorology. Line of sight [redacted] to balloon is taken at 30 miles to allow for terrain features. 25X1

The following diagram outlines the situation:



Agent at X

X-A = 30 miles = Line of sight to PB

A-B = 43 miles = max. distance P. B. can travel before being carried out of radio control range after pickup of the homing signal

CD = 20 miles = max. resultant vector P. B. must fly to correct for wind drift

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Plugging a speed of 20 knots into this situation allows the P. B. to insure overflying [redacted] with 20 knot winds. 25X1

Using the equation drag = $\frac{1}{2} \times P_0 C_D V^2 V^{2/3}$ the drag for 20 knots is found to be 2.6 at altitude, 3.5 on the surface. Then the maximum horsepower required is .286. Assuming electrical conversion and propeller efficiency this becomes .372 H.P. for 20 knots.

Gross Load lbs.	Pay Load lbs.	Volume cu. ft.	Length ft.	Max. Diam. ft.	Ft. Alt. ft.	Speed knots	Horsepower
18	1	375	18	6	10,000	20	.372

This power requirement falls in model airplane engine range. A .5 H.P. engine is rated at 1 oz. of fuel/minute. Assuming this figure (of 7#/H.P.-hour) can be reduced to 2#/H.P.-hour 3 pounds of fuel would theoretically suffice for a 5 hour flight time.

In the event the weights have been grossly miscalculated the above figures are repeated for a gross weight of 50 pounds and given in tabular form as follows:

Gross Load lbs.	Pay Load lbs.	Volume cu. ft.	Length ft.	Max. Diam. ft.	Flt. Alt. ft.	Speed knots	Horsepower
50	1	1010	26.18	8.74	10,000	20	.406

Thus power and size requirements are not significantly affected therefore the costs should be essentially the same.

4. Cost:

Balloon	$ 350.00
Guidance and instrumentation	300.00
Propulsion	100.00
Destructor device 100% reliable	50.00
Sub-total	$ 800.00

Radio or IR gear to meet control requirements with servo mechanisms applied to guidance system (ADF) from $200,00 - $5,000.00.

Probable minimum cost for unit	$ 1000.00
Maximum cost	$ 5800.00

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5. An alternate method to that proposed involves the use of a small, high altitude homing glider. This equipment might consist of the following: a small free balloon to carry the glider to very high altitudes, perhaps as high as 19 miles; a radio switch to detach the glider; and a glider equipped with a homing mechanism enabling it to home on a ground beacon. The operation involves launching the balloon and glider outside a denied area and having the unit home on a beacon inside the denied area.

6. Glide ratio exceeding 10:1 for small gliders at high altitudes are proposed. It is easily seen that ranges in excess of 100 miles are readily obtained with almost any wind condition from high altitudes. With favorable winds very long ranges and small gliders should be possible. Automatic direction finding equipment capable of meeting the requirements of the glider is believed to be obtainable for costs lower than $500.00 and weights less than 10 pounds using radio gear. IR equipment could be considered but would undoubtedly increase this cost figure. With instrumentation weighing 8 pounds, a glider with approximately a 10 foot wing span, weighing 15 pounds is considered for flight altitudes as high as 100,000 feet. There are many variables to consider in the design of such a glider, among them are indicated air speed, sinking speed, glide ratio, size and stability. All of these change markedly with altitude. A systematic program would be needed to establish the most favorable aerodynamic performance using values for estimated wind conditions, payload and range.

7. The cost of the glider is estimated at about the same as the powered balloon. The main advantages seen are quietness of operation and more independance of wind conditions. The main disadvantage might be the need for destruction of the glider upon completion of the mission.

8. Should any of the estimated performance values for the powered balloon and/or glider indicate probable usefulness of the items for support of clandestine operations, it is recommended that at least a limited program be initiated to prove the accuracy of these estimates. From such a program further development of hardware could be made if required. TSS/ED would be most interested in such a program and actively seeks an expression of interest from appropriate Agency divisions.